

$$\sum_{i=0}^{n-1} i = 0 + 1 + 2 + 3 + \dots + (n-1) = \frac{n(n-1)}{2}$$

Examples:

$$n=5 : \sum_{i=0}^4 i = 0 + 1 + 2 + 3 + 4 = \frac{5(5-1)}{2} = 10$$

$$n=7 : \sum_{i=0}^6 i = 0 + 1 + 2 + 3 + 4 + 5 + 6 = \frac{7(7-1)}{2} = 21$$

$$\sum_{i=0}^{n-2} (n-1-i) = (n-1) + (n-2) + (n-3) + \dots + 1 = \frac{n(n-1)}{2}$$

Examples:

$$n=5 : \sum_{i=0}^3 (5-1-i) = 4 + 3 + 2 + 1 = \frac{5(5-1)}{2} = 10$$

$$n=7 : \sum_{i=0}^6 (7-1-i) = 6 + 5 + 4 + 3 + 2 + 1 = \frac{7(7-1)}{2} = 21$$

1-Bubble Sort

```
for (int i = 0; i < n-1; i++)  
    for (int j = n-1; j > i; --j)  
        if (data[j] < data[j-1])  
            swap(data[j], data[j-1]);
```

عدد مرات تكرار
الحلقة الخارجية هو:
from 0 to n-2

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الجملة الشرطية يساوي
(n-1) - i = n-1-i

$$\sum_{i=0}^{n-2} (n-1-i) = \frac{n(n-1)}{2} = O(n^2)$$

2-Selection Sort

```
for (int i = 0, j, least; i < n-1; i++) {
    for (j = i+1, least = i; j < n; j++)
        if (data[j] < data[least])
            least = j;
    swap(data[least], data[i]);
}
```

عدد مرات تكرار الحلقة
الخارجية يساوي:
n-2 (from 0 to n-2)

عدد مرات تكرار الحلقة
الداخلية يساوي:
(from i+1 to n-1)
=n-i-1

$$\sum_{i=0}^{n-2} (n-1-i) = (n-1) + \dots + 1 = \frac{n(n-1)}{2} = O(n^2)$$

3-Insertion Sort

```
for (int i = 1, j; i < n; i++) {
    T tmp = data[i];
    for (j = i; j > 0 && tmp < data[j-1]; j--)
        data[j] = data[j-1];
    data[j] = tmp;
}
```

عدد مرات تكرار الحلقة
الخارجية يساوي :
n-1

عدد مرات تنفيذ الحلقة الداخلية يساوي : i

$$\sum_{i=1}^{n-1} i = 1 + 2 + \dots + (n-1) = \frac{n(n-1)}{2} = O(n^2)$$

To find the number of movements and comparisons performed by insertion-sort(), observe first that the outer for loop always performs $n-1$ iterations. However, the number of elements greater than $\text{data}[i]$ to be moved by one position is not always the same.